METHOD AND APPARTUS FOR DRIVING ELECTRO-LUMINESCENCE DISPLAY PANEL DESIGNED TO PERFORM EFFICIENT BOOTING

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the priority of Korean Patent Application No. 2003-23713, filed on April 15, 2003, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference in its entirety.

1. Field of the Invention

[0002] The present invention relates to a method and apparatus for driving an electro-luminescence (EL) display panel, and more particularly, to a method and apparatus for driving an EL display panel having electro-luminescence cells formed at intersections between data and scanning electrode lines crossing each other at a predetermined distance.

2. Background of the Invention

[0003] Referring to FIG. 1, a conventional EL display device includes an EL display panel 2 and a driving circuit. The driving circuit comprises a controller 21, a scanning driving unit 6, and a data driving unit 5. The EL display panel 2 has a plurality of data electrode lines 3 and scanning electrode lines 4 intersecting each other at a predetermined distance. The EL display panel 2 further has electro-luminescence cells 1, each being formed at the intersections between the data electrode lines 3 and the scanning electrode lines 4.

[0004] The controller 21 receives and processes image signals $S_{IM.}$ The processing includes applying data control signals S_{DA} and scanning control signals S_{SC} to the data driving unit 5 and the scanning driving unit 6, respectively. The data control signals S_{DA} include the display data signals and the switching control signals, while the scanning control signals S_{SC} are the switching control signals.

[0005] The data driving unit 5 connected to the signal-input terminals of the data electrode lines 3 produces data current signals, corresponding to the display data signals from the controller 21 in response to the switching control signals received from the controller 21, and applies the data current signals to the data electrode lines 3. Here, reference number 8 denotes current sources.

[0006] The scanning driving unit 6 connected to the signal-input terminals of the scanning electrode lines 4 sequentially applies scanning driving signals, in response to the switching control signals received from the controller 21, to the scanning electrode lines 4.

[0007] Referring to FIG. 1 and FIG. 2, the data driving unit 5 of the EL display device of FIG. 1 includes an interface 30, a latch circuit 31, digital-to-analog (D/A) converters 32, and an output circuit 33.

[0008] The latch circuit 31, operating according to a horizontal synchronization signal H_{SYNC} received from the controller 21 through the interface 30, periodically stores the display data signals D_{DA} received from the controller 21 through the interface 30 while periodically outputting display data signals in the current and next horizontal drive time periods, respectively. Each of the D/A converters 32 converts each of the display data signals in the current horizontal drive time period received from the latch circuit 31 into a data current signal. The output circuit 33 then applies data output signals I_{D1}-I_{Dm},corresponding to the display data signals received from the D/A converters 32, to the corresponding data electrode lines 3, respectively.

[0009] As an example of a conventional EL display device configured as above, U .S Patent No. 6,531,827 discloses a technology for improving driving speed by applying booting current at the beginning of each horizontal drive time period. European Laid-open Patent Publication No. 1,091,340 proposes a technology for reducing power consumption by controlling

the booting current according to a change in the amount of data. A conventional driving apparatus and method using the above-cited technologies will now be described.

[0010] Referring to FIGS. 1, 2 and 3, the latch circuit 31 of the data driving unit 5 of FIG. 2 generally comprises (n+1)-data registers 31_{R1}-31_{Rm} and n-data latches 31_{L1}-31_{Lm}. The output circuit 33 of the data driving unit 5 includes digital comparators 33_{C1}-33_{Cm}, D/A converters 33_{D1}-33_{Dm}, and output current switches S_1-S_m.

[0011] Each of the (n+1)-data registers 31_{R1}-31_{Rm} outputs a display data signal stored therein according to the horizontal synchronization signal H_{SYNC} and stores a display data signal D_{n+1} received from the controller 21 through the interface 30. The n-data latches 31_{L1}-31_{Lm} output display data signals stored therein in response to the horizontal synchronization signal H_{SYNC} and store the display data signals D_n received from the (n+1)-data registers 31_{R1}-31_{Rm}, respectively. The D/A converters 32_1 - 32_m then convert the display data signals D_n in the current horizontal drive time period received from the n-data latches 31_{L1}-31_{Lm} into data current signals I_{DP1}-I_{DPm}, respectively.

[0012] The digital comparators 33_{C1}-33_{Cm} of the output circuit 33 compare the display data signals D_n in the current horizontal drive time period received from n-data latches 31_{L1}-31_{Lm} with the display data signals D_{n+1} in the next horizontal drive time period received from (n+1)-data registers 31_{R1}-31_{Rm}, respectively. The digital comparators 33_{C1}-33_{Cm} generate booting data signals according to the comparison results. The D/A converters 33_{D1}-33_{Dm} convert the booting data signals received from the digital comparators 33_{C1} -33_{Cm} into analog signals and output booting current signals I_{B1}-I_{Bm}, respectively. The output current switches S_1-S_m apply data output signals I_{D1}-I_{Dm} to the data electrode lines 3, respectively. The data output signals I_{D1}-I_{Dm} are generated by alternately selecting the output signals I_{B1}-I_{Bm} of the D/A converters 33_{D1}-

33_{Dm} of the output circuit 33 or output signals I_{DP1}-I_{DPm} of the D/A converters 32_1-32_m, respectively.

[0013] A method for driving a conventional EL display device having a data driving unit 5 as shown in FIG. 3 will now be described with reference to FIGS. 3 and 4. In FIG. 4, reference character I_{DP1} is a data current signal from D/A converter 32_1, I_{D1} is a data output signal applied to the data electrode line (3a of FIG. 1) from the output current switch S_1 corresponding to the D/A converter 32_1, V_{D1} is a data voltage signal applied to the data electrode line 3a, and V_{S1}-V_{S6} are scanning voltage signals applied to the scanning electrode lines (4 of FIG. 1).

[0014] With reference to the data output signal I_{D1}, a booting current corresponds to a magnitude change of a display data signal D_{n+1} in a next horizontal drive time period with respect to a display data signal D_n in a current horizontal drive time period. The booting current is applied to the data electrode line 3a at the beginning of the next horizontal drive time period. An instantaneous value of the booting current is proportional to a magnitude change of the data current signal I_{DP1}. In connection therewith, first and second drive periods t1~t3 and t3~t5 will now be representatively described.

[0015] The magnitude of the data current signal I_{DP1} at the scanning time interval t2~t3 increases over that of the data current signal I_{DP1} at the previous scanning time interval (not shown) during booting time interval t1~t2 of the first horizontal drive period t1~t3. A positive polarity booting current, proportional to the amount by which the magnitude of the data current signal I_{DP1} at the scanning time interval t2~t3 increases from the previous scanning time interval, is applied to the data electrode line 3a.

[0016] Conversely, the magnitude of the data current signal I_{DP1} at scanning time interval t4~t5 decreases over that of the data current signal I_{DP1} at the previous scanning time interval

t2~t3 during booting time interval t3~t4 of the second horizontal drive period t3~t5. A negative polarity booting current, proportional to the amount by which the magnitude of the data current signal I_{DP1} at the scanning time interval t4~t5 decreases from the previous scanning time interval t2~t3, is applied to the data electrode line 3a.

[0017] Thus, the typical driving apparatus and method can improve the driving speed using the booting current. However, since the instantaneous value of booting current are proportional to the magnitude change of the data current signal I_{DP1}, the instantaneous value of booting current may increase significantly when the change becomes very large. This may cause crosstalk such that EL cells that are not scanned glow, as well as increase power consumption.

SUMMARY OF THE INVENTION

[0018] The present invention provides a method and apparatus for driving an electro-luminescence (EL) display panel designed to prevent occurrences of crosstalk, that is, when EL cells not scanned emit light, and reduce power dissipation, by efficiently applying a booting current for high speed operation at the beginning of a horizontal drive period.

[0019] According to an aspect of the present invention, there are provided a method and apparatus for driving an electro-luminescence (EL) display panel having data electrode lines and scanning electrode lines intersecting each other at a predetermined distance and EL cells, where each EL cell is formed at the intersections thereof. In the method and apparatus, a booting current, corresponding to a magnitude change of a display data signal in the next horizontal drive time period with respect to a display data signal in the current horizontal drive time period, is applied to each of the data electrode lines at the beginning of the next horizontal drive time period. Instantaneous values of the booting currents are kept constant, and the application time for the booting current is proportional to a magnitude change of each display data signal in the

next horizontal drive time period with respect to the display data signal in the current horizontal drive time period.

[0020] The method and apparatus for driving the EL display panel make the instantaneous values of the booting currents constant by adjusting the power required for the booting currents according to the application time. Thus, since it is possible to limit excessive increases in instantaneous values of the booting currents, this invention may prevent occurrences of crosstalk caused by unscanned EL cells emitting light, while reducing power consumption.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The above and other features and advantages of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings.

[0022] FIG. 1 shows the configuration of a conventional electro-luminescence (EL) display device.

[0023] FIG. 2 is a block diagram showing the configuration of the data driving unit shown in FIG. 1.

[0024] FIG. 3 is a detailed block diagram showing a conventional interior configuration of the data driving unit of FIG. 2.

[0025] FIG. 4 is a timing diagram for explaining a method for driving a conventional EL display device having the data driving unit of FIG. 3.

[0026] FIG. 5 is a detailed block diagram showing an interior configuration of the data driving unit of FIG. 2 according to the present invention.

[0027] FIG. 6 is a timing diagram for explaining a method for driving an EL display device having the data driving unit of FIG. 5 according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0028] Since the basic configuration and operation of the conventional driving circuit described earlier with reference to FIGS. 1 and 2 also apply to a driving apparatus of this invention, a detailed description thereof will not be given.

[0029] Referring to FIGS. 1, 2, and 5, a latch circuit 51 of the data driving unit 5 of FIG. 2, according to the present invention, comprises (n+1)-data registers 51_{R1}-51_{Rm} and n-data latches 51_{L1}-51_{Lm}. An output circuit 53 of the data driving unit according to the invention includes digital comparators 53_{C1} -53_{Cm}, current sources 53_{S1}-53_{Sm}, booting-current switches S_{B1}-S_{Bm}, timing signal generators 53_{T1}-53_{Tm}, and output current switches S_1-S_m.

[0030] Each of the (n+1)-data registers 51_{R1}-51_{Rm} outputs a display data signal stored therein according to horizontal synchronization signal H_{SYNC}, and stores a display data signal D_{n+1} received from the controller (21 of FIG. 1) through the interface (30 of FIG. 2). The n-data latches 51_{L1}-51_{Lm} output display data signals stored therein in response to horizontal synchronization signal H_{SYNC}, and store the display data signals D_n received from the (n+1)-data registers 51_{R1}-51_{Rm}, respectively. Digital-to-analog (D/A) converters 52_1 -52_m then convert the display data signals D_n in the current horizontal drive time period received from the n-data latches 51_{L1}-51_{Lm} into data current signals I_{DP1}-I_{DPm}, respectively.

[0031] The digital comparators 53_{C1}-53_{Cm} of the output circuit 53 compare the display data signals D_n in the current horizontal drive time period received from n-data latches 51_{L1}-51_{Lm} with the display data signals D_{n+1} in the next horizontal drive time period received from (n+1)-data registers 51_{R1}-51_{Rm}, respectively. The digital comparators 53_{C1}-53_{CM} generate signals indicating a magnitude change of the display data signals D_{n+1} with respect to display data signals D_n and generate signals indicating the amount of the change.

[0032] The current sources 53_{S1}-53_{Sm} output booting currents having constant

instantaneous values and varying polarities depending on the magnitude change in the signals. Taking a data electrode line as an example, if the magnitude of display data signal D_{n+1} in the next horizontal drive time period increases over that of display data signal D_n in the current horizontal drive time period, a current source corresponding to the data electrode line outputs a positive polarity booting current during the next horizontal drive time period. Conversely, if the magnitude of display data signal D_{n+1} in the next horizontal drive time period decreases over that of display data signal D_n in the current horizontal drive time period, the current source corresponding to the data electrode line outputs a negative polarity booting current during the next horizontal drive time period. Since the booting currents are applied to the data electrode lines (3 of FIG. 1) at the beginning of each horizontal drive time period, it is possible to increase the speed at which the voltage is applied, *i.e.*, driving speed for the EL cells (1 of FIG. 1), despite the presence of parasitic capacitance at the EL cells 1.

[0033] The booting-current switches S_{B1}-S_{Bm} switch the booting currents I_{B1}-I_{Bm} output from the current sources 53_{S1}-53_{Sm}, respectively. The timing signal generators 53_{T1}-53_{Tm} control timing for operation of the booting-current switches S_{B1}-S_{Bm} according to the signals indicating the amount of change received from the digital comparators 53_{C1}-53_{Cm}. Specifically, the timing signal generators 53_{T1}-53_{Tm} allow the booting-current switches S_{B1}-S_{Bm} to remain ON for a period proportional to the amount of magnitude change of display data signals at the beginning (t1~t3, t4~t6, t7~t9, t10~t12, t13~t15, or t16~t18 of FIG. 6) of each horizontal drive time period, respectively.

[0034] The power required for booting currents is adjusted by the amount of application time, which causes instantaneous values of the booting currents I_{B1}-I_{Bm} to be kept constant. Thus, it is possible to limit excessive increases in the instantaneous values of the booting currents

I_{B1}-I_{Bm}, which prevents occurrences of crosstalk, that is, unscanned EL cells emitting light, while reducing power consumption.

[0035] The output current switches S_1-S_m apply data output signals I_{D1}-I_{Dm} to the data electrode lines 3, respectively. The data output signals I_{D1}-I_{Dm} are generated by alternately selecting from the output signals I_{B1}-I_{Bm} of the booting-current switches S_{B1}-S_{Bm} and the output signals I_{DP1}-I_{DPm} of the D/A converters 52_1-52_m, respectively.

[0036] A method for driving an EL display device having the data driving unit of FIG. 5 according to the present invention, will now be described with reference to FIGS. 5 and 6. In FIG. 6, reference character I_{DP1} is a data current signal from a D/A converter 52_1, I_{D1} is a data output signal applied to the data electrode line (3a of FIG. 1) from the output current switch S_1 corresponding to the D/A converter 52_1, V_{D1} is a data voltage signal applied to the data electrode line 3a, and V_{S1}-V_{S6} are scanning voltage signals applied to the scanning electrode lines (4 of FIG. 1).

[0037] With reference to the data output signal I_{D1}, a booting current, corresponding to a magnitude change of a display data signal D_{n+1} in the next horizontal drive time period with respect to a display data signal D_n in the current horizontal drive time period, is applied to the data electrode line 3a at the beginning t1~t3, t4~t6, t7~t9, t10~t12, t13~t15 or t16~t18 of the next horizontal drive time period. This makes it possible to increase speed in which the of voltage is applied, i.e., a driving speed for the EL cells (1 of FIG. 1), despite the presence of parasitic capacitance at the EL cells 1.

[0038] While an instantaneous value I_{REF} of booting current is kept constant, the amount of application time t1~t2, t4~t5, t7~t8, t10~t11, t13~t14 or t16~t17 for the booting current is proportional to the amount of magnitude change of the data current signal I_{DP1}. Thus, the power

required for booting current I_{B1} is adjusted by the amount of application time to keep an instantaneous value of the booting current I_{B1} constant. It is possible to limit excessive increases in the instantaneous value of the booting current I_{B1}, which prevents occurrences of crosstalk, that is, unscanned EL cells emitting light, while reducing power consumption. In connection therewith, first and second drive periods t1~t3 and t4~t7 will now be representatively described.

[0039] The magnitude of the data current signal I_{DP1} during scanning time interval t3~t4 increases over that of the data current signal I_{DP1} during the previous scanning time interval (not shown) at the beginning t1-t3 of the first horizontal drive period t1~t4. An instantaneous value $+I_{REF}$ of positive polarity booting current is applied to the data electrode line 3a. Here, the application time interval t1~t2 is proportional to the amount by which the magnitude of the data current signal I_{DP1} at the scanning time interval t3-t4 increases from previous scanning time interval.

[0040] Conversely, the magnitude of the data current signal I_{DP1} during scanning time interval t6~t7 decreases over that of the data current signal I_{DP1} during the previous scanning time interval t3~t4 at the beginning of the second horizontal drive period t4~t7. An instantaneous value $-I_{REF}$ of negative polarity booting current is applied to the data electrode line 3a. Here, the application time interval t4-t5 is proportional to the amount by which the magnitude of the data current signal I_{DP1} during the scanning time interval t6~t7 decreases from the previous scanning time interval t3~t4.

[0041] As described above, the method and apparatus for driving an EL display panel according to the present invention make it possible to keep instantaneous values of booting currents constant by adjusting the power required for the booting currents, depending on the amount of application time. Since it is possible to limit excessive increases in instantaneous

values of booting currents, this invention may prevent occurrences of crosstalk, that is, when unscanned EL cells emit light, while reducing power consumption.

[0042] While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.